Interim Availability Interconnection System Impact Study for Generator Interconnection

GEN-2016-098

March 2018
Generator Interconnection

Revision History

Date	Author	Change Description
03/15/2018	SPP	Interim Availability Interconnection System Impact Study (IAISIS) for Generator Interconnection Request GEN-2016-098 Report Revision 0 Issued

Executive Summary

GEN-2016-098 (Interconnection Customer) has requested an Interim Availability Interconnection System Impact Study (IAISIS) under Section 11A of Attachment V (Generator Interconnection Procedures - GIP) to the Southwest Power Pool Open Access Transmission Tariff (OATT). GEN-2016-098 has requested 250 MW of wind generation be interconnected with Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS) into the transmission system of Oklahoma Gas and Electric (OKGE) in Harper County, Oklahoma. GEN-2016-098 has requested this IAISIS to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2016-001 (or most recent iteration) Impact Study can be placed into service.

This IAISIS addresses the effects of interconnecting the generator to the rest of the transmission system for the system topology and conditions as expected on October 1, 2020. GEN-2016-098 is requesting the interconnection of one hundred (100) GE 2.5 MW wind turbines and associated facilities interconnecting at a new substation tapping Woodward – Hitchland 345 kV. For this IAISIS, power flow, stability and short circuit analyses were conducted. This IAISIS assumes only the higher queued projects listed within Table 1 of this study might go into service before the completion of all Network Upgrades identified within
Table *2* of this report. If additional generation projects, listed within Table 3, with queue priority equal to or higher than the study project request rights to go into commercial operation before all Network Upgrades identified within
Table *2* of this report are completed, this IAISIS may need to be restudied to ensure that interconnection service remains for the customer's request.

Power flow and stability analysis from this IAISIS has determined that GEN-2016-098 can interconnect 250 MW of wind generation with Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS) on October 1, 2020, pending the completion of the required Network Upgrades, listed within
Table 2 of this report. Should any other projects, other than those listed within Table 1 of this report, come into service, an additional study may be required to determine if any limited operation service is available. It should be noted that while this IAISIS analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator may not be able to inject any power onto the Transmission System due to constraints that fall below the threshold of mitigation for a Generator Interconnection request. Because of this, it is likely that the Customers may be required to reduce their generation output to **0 MW** under certain system conditions to allow system operators to maintain the reliability of the transmission network.

In accordance with FERC Order 827 GEN-2016-098 will be required to provide dynamic reactive power within the power factor range of 0.95 leading (absorbing Vars from the network) to 0.95 lagging (providing Vars to the network) at continuous rated power output at the high side of the generator substation. Additionally, the analysis shows that the generator will meet the Low Voltage Ride-Through (LVRT) requirements of FERC Order 661A.

Nothing in this study should be construed as a guarantee of delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

Table of Contents

Purpose

GEN-2016-098 (Interconnection Customer) has requested an Interim Availability Interconnection System Impact Study (IAISIS) under the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT) for interconnection requests into the integrated transmission system of Oklahoma Gas & Electric (OG&E).

The purpose of this study is to evaluate the impacts of interconnecting GEN-2016-098 request with a total of 250 MW comprised of one hundred (100) GE 2.5 MW and associated facilities interconnecting at a new substation tapping Woodward – Hitchland 345 kV in Harper County, Oklahoma. The Interconnection Customer has requested this amount to be studied with Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS) to commence on or around October 2020.

Power flow, transient stability, and short circuit analyses were conducted for this IAISIS in accordance with GIA Section 11A.

The IAISIS considers the Base Case as well as all Generating Facilities (and with respect to (c) below, any identified Network Upgrades associated with such higher queued interconnection) that, on the date the IAISIS is commenced:

a) are directly interconnected to the Transmission System;
b) are interconnected to Affected Systems and may have an impact on the Interconnection Request;
c) have a pending higher queued Interconnection Request to interconnect to the Transmission System listed in Table 1; or
d) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study executing an interconnection agreement and commencing commercial operation, may require a re-study of this IAISIS at the expense of the Customer.

Nothing within this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service rights. Should the Customer require transmission service, those rights should be requested through SPP’s Open Access Same-Time Information System (OASIS).

This IAISIS study included prior queued generation interconnection requests. Those listed within Table 1 are the generation interconnection requests that are assumed to have rights to either full or partial interconnection service prior to the requested October 2020 in-service for this IAISIS. Also listed in Table 1 are both the amount of MWs of interconnection service expected at the effective time of this study and the total MWs requested of interconnection service, the fuel type, the point of interconnection (POI), and the current status of each particular prior queued request.

Table 1: Generation Requests Included within IAISIS

Project	MW	Total MW	Fuel Source	POI	Status
GEN-2001-014	94.5	94.5	Wind	Ft Supply 138kV	Commercial Operation
GEN-2001-037	102	102	Wind	FPL Moreland Tap 138kV	Commercial Operation
GEN-2005-008	120	120	Wind	Woodward 138kV	Commercial Operation
GEN-2006-024S	18.9	18.9	Wind	Buffalo Bear Tap 69kV	Commercial Operation
GEN-2006-046	130	130	Wind	Dewey 138kV	Commercial Operation
GEN-2007-021	100	100	Wind	Tatonga 345kV	Commercial Operation
GEN-2007-021	100	100	Wind	Tatonga 345kV	Commercial Operation
GEN-2007-043	200	200	Wind	Minco 345kV	Commercial Operation
GEN-2007-044	100	100	Wind	Tatonga 345kV	Commercial Operation
GEN-2007-044	100	100	Wind	Tatonga 345kV	Commercial Operation
GEN-2007-044	100	100	Wind	Tatonga 345kV	Commercial Operation
GEN-2007-050	18.4	18.4	Wind	Woodward EHV 138kV	Commercial Operation
GEN-2007-050	151.8	151.8	Wind	Woodward EHV 138kV	Commercial Operation
GEN-2007-062	212	212	Wind	Woodward EHV 345kV	Commercial Operation
GEN-2007-062	213	213	Wind	Woodward EHV 345kV	Commercial Operation
GEN-2008-003	101.2	101.2	Wind	Woodward EHV 138kV	Commercial Operation
GEN-2008-044	98.9	98.9	Wind	Tatonga 345kV	Commercial Operation
GEN-2008-044	98.9	98.9	Wind	Tatonga 345kV	Commercial Operation
GEN-2010-011	29.7	29.7	Wind	Tatonga 345kV	Commercial Operation
GEN-2010-040	150	150	Wind	Cimarron 345kV	Commercial Operation
GEN-2010-040	150	150	Wind	Cimarron 345kV	Commercial Operation
GEN-2011-010	100.8	100.8	Wind	Minco 345kV	Commercial Operation
GEN-2011-019	175	175	Wind	Woodward 345kV	On Schedule
GEN-2011-054	200	200	Wind	Cimarron 345kV	On Schedule
GEN-2011-054	100	100	Wind	Cimarron 345kV	On Schedule
GEN-2014-002	10.53	10.53	Wind	Tatonga 345kV (GEN-2007-021 POI)	On Schedule
GEN-2014-003	15.04	15.04	Wind	Tatonga 345kV (GEN-2007-044 POI)	On Schedule
GEN-2014-005	5.67	5.67	Wind	Minco 345kV (GEN-2011-010 POI)	On Schedule
GEN-2014-020	100	100	Wind	Tuttle 138kV	On Schedule
GEN-2014-056	250	250	Wind	Minco 345kV	On Schedule
GEN-2015-029	161	161	Wind	Tatonga 345kV	On Suspension
GEN-2015-048	200	200	Wind	Cleo Corner 138kV	On Suspension
GEN-2015-057	100	100	Wind	Minco 345kV Sunstation	Facility Study Stage
GEN-2015-093	140	140	Wind	Gracemont 345kV	IA Pending
GEN-2015-093	110	110	Wind	Gracemont 345kV	IA Pending

Table 1: Generation Requests Included within IAISIS

Project	MW	Total MW	Fuel Source	POI	Status
GEN-2015-095	176	176	Wind	Tap Mooreland - Knob Hill 138kV	Facility Study Stage
GEN-2016-003	248.4	248.4	Wind	Hitchland-Woodward 345 kV	Facility Study Stage
GEN-2016-020	150	150	WIND	Moreland 138kV Substation	Facility Study Stage
GEN-2016-045	250.7	250.7	Wind	Mathewson 345 kV	Facility Study Stage
GEN-2016-045	250.7	250.7	Wind	Mathewson 345 kV	Facility Study Stage
GEN-2016-047	67	59	CT	Mustang 69kV	Facility Study Stage
GEN-2016-047	67	59	CT	Mustang 69kV	Facility Study Stage
GEN-2016-047	67	59	CT	Mustang 69kV	Facility Study Stage
GEN-2016-047	67	59	CT	Mustang 69kV	Facility Study Stage
GEN-2016-047	67	59	CT	Mustang 69kV	Facility Study Stage
GEN-2016-047	67	59	CT	Mustang 69kV	Facility Study Stage
GEN-2016-047	67	59	CT	Mustang 69kV	Facility Study Stage
GEN-2016-057	250.7	250.7	Wind	Mathewson 345 kV	Facility Study Stage
GEN-2016-057	250.7	250.7	Wind	Mathewson 345 kV	Facility Study Stage
GEN-2016-098	250	250	Wind	Woodward EHV-Hitchland 345 kV	DISIS Stage

This IAISIS was requested because the Interconnection Customer anticipates that the required studies will not be complete prior to the requested in-service date.

Table *2* below lists the required upgrade projects for which these requests have cost responsibility. GEN-2016-098 was included within the DISIS-2016-002 that will be studied in spring 2018 and posted end of first quarter, 2018. Once posted the report will be located at the following Generation Interconnection Study URL:
http://sppoasis.spp.org/documents/swpp/transmission/GenStudies.cfm?YearType=2016_Impact_Studies

Table 2: Upgrade Projects not included but Required for Full Interconnection Service

Upgrade Project	Type	Description	Status	Study Assignment
No upgrades are required at this time. However, the study assumes all previously assigned upgrades and prior queued requests will go forward. Should any higher queued request withdraw, all associated upgrades are subject to review; possibly triggering a restudy.				

While several thermal and voltage overloads observed in Scenario 0 (DISIS-2016-001-01 models with no upgrades included), all of these overloads were mitigated by previously assigned upgrades. It is therefore important to emphasize that should any previously assigned upgrade become subject to restudy (via withdrawal of a higher queued request), this IAISIS will also be subject to restudy.

Again, any changes to these assumptions, for example, one or more of the previously queued requests not included within this study executing an interconnection agreement and commencing commercial operation, may require a re-study of this IAISIS at the expense of the Interconnection Customer.

The higher or equally queued projects that were not included in this study are listed in Table 3. While this list is not all-inclusive, it is a list of the most probable and affecting prior-queued requests that were not included within this IAISIS, either because no request for an IAISIS has been made or the request is on suspension, etc.

Table 3: Higher or Equally Queued GI Requests not included within IAISIS

Project	MW	Total MW	Fuel Source	POI	Status
No projects were excluded from this study.					

Nothing in this System Impact Study constitutes a request for transmission service or grants the Interconnection Customer any rights to transmission service.

Facilities

Generating Facility

The Interconnection Customer's request to interconnect one hundred (100) GE 2.5 MW wind turbines and associated facilities interconnecting at a new substation tapping Woodward – Hitchland 345 kV.

Interconnection Facilities

The POI for GEN-2016-098 Interconnection Customer is a new substation tapping Woodward – Hitchland 345 kV in Harper County, Oklahoma. *Figure 1* depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the requests.

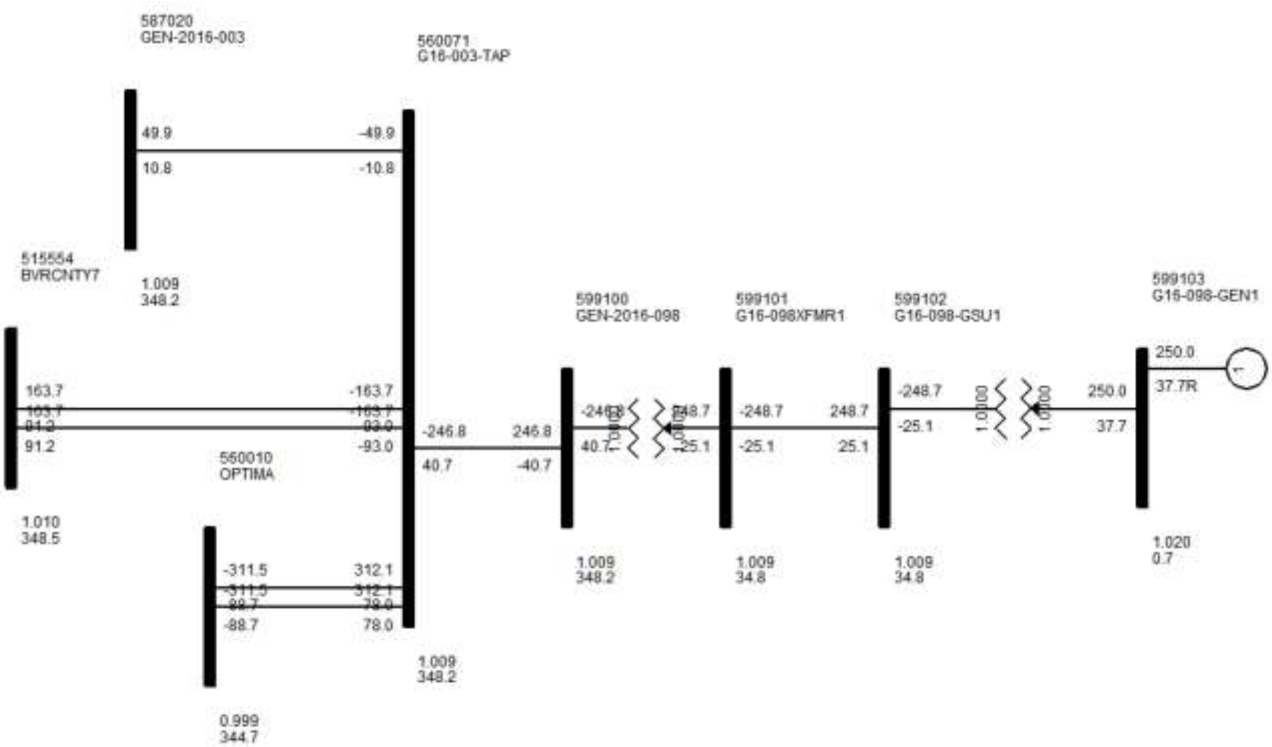


Figure 1: Proposed POI Configuration and Request Power Flow Model

Base Case Network Upgrades

The Network Upgrades included within the cases used for this IAISIS study are those facilities that are a part of the SPP Transmission Expansion Plan, Balanced Portfolio, or Integrated System (IS) Integration Study projects that have in-service dates prior to the GEN-2016-098 requested in-service date of October 1, 2020. These facilities have an approved Notification to Construct (NTC), or are in construction stages and expected to be in-service at the effective time of this study. No other upgrades were included for this IAISIS. If for some reason, construction on these projects is delayed or discontinued, a restudy may be needed to determine the interconnection service availability of the Customer.

Power Flow Analysis

Power flow analysis is used to determine if the transmission system can accommodate the injection from the request without violating thermal or voltage transmission planning criteria.

Model Preparation

Power flow analysis was performed using modified versions of the 2015 series of transmission service request study models including the 2016 Winter Peak (16WP), 2017 Spring (17G), and 2017 Summer Peak (17SP), 2020 Light (20L), and 2020 Summer (SP) and Winter (WP) peak seasonal models. To incorporate the Interconnection Customers' request, a re-dispatch of existing generation within SPP was performed with respect to the amount of the Customers' injection.

For Variable Energy Resources (VER) (solar/wind) in each power flow case, Energy Resource Interconnection Service (ERIS), is evaluated for the generating plants within a geographical area of the interconnection request(s) for the VERs dispatched at 100% nameplate of maximum generation. The VERs in the remote areas is dispatched at 20% nameplate of maximum generation. These projects are dispatched across the SPP footprint using load factor ratios.

Peaking units are not dispatched in the 2017 spring and 2020 light, or in the "High VER" summer and winter peaks. To study peaking units' impacts, the 2016 winter peak, 2017 summer peak, and 2020 summer and winter peaks, models are developed with peaking units dispatched at 100% of the nameplate rating and VERs dispatched at 20% of the nameplate rating. Each interconnection request is also modeled separately at 100% nameplate for certain analyses.

All generators (VER and peaking) that requested Network Resource Interconnection Service (NRIS) are dispatched in an additional analysis into the interconnecting Transmission Owner's (T.O.) area at 100% nameplate with Energy Resource Interconnection Service (ERIS) only requests at 80% nameplate. This method allows for identification of network constraints that are common between regional groupings to have affecting requests share the mitigating upgrade costs throughout the cluster.

For this IAISIS, only the previous queued requests listed in Table 1 were assumed to be in-service at 100% dispatch.

Study Methodology and Criteria

Network constraints are found by using PSS/E AC Contingency Calculation (ACCC) analysis with PSS/E MUST First Contingency Incremental Transfer Capability (FCITC) analysis on the entire cluster grouping dispatched at the various levels previously mentioned.

For Energy Resource Interconnection Service (ERIS), thermal overloads are determined for system intact (n-0) (greater than 100% of Rate A - normal) and for contingency (n-1) (greater than 100% of Rate B – emergency) conditions.

The overloads are then screened to determine which of generator interconnection requests have at least

- 3% Distribution Factor (DF) for system intact conditions (n-0),
- 20% DF upon outage based conditions (n-1), or
- 3% DF on contingent elements that resulted in a non-converged solution.

Interconnection Requests that requested Network Resource Interconnection Service (NRIS) are also studied in a separate NRIS analysis to determine if any constraint measured greater than or equal to a 3% DF. If so, these constraints are also considered for transmission reinforcement under NRIS.

The contingency set includes all SPP control area branches and ties 69kV and above, first tier Non-SPP control area branches and ties 115 kV and above, any defined contingencies for these control areas, and generation unit outages for the SPP control areas with SPP reserve share program redispatch.

The monitor elements include all SPP control area branches, ties, and buses 69 kV and above, and all first tier Non-SPP control area branches and ties 69 kV and above. NERC Power Transfer Distribution Flowgates for SPP and first tier Non-SPP control area are monitored. Additional NERC Flowgates are monitored in second tier or greater Non-SPP control areas. Voltage monitoring was performed for SPP control area buses 69 kV and above.

Results

The IAISIS ACCC analysis indicates that the Interconnection Customer may interconnect its generation into the OKGE transmission system pending all current study and previously assigned upgrades outlined in the DISIS-2016-001-01. Should any other GI projects, other than those listed within Table 1 of this report, come into service, an additional study may be required to determine if any limited operation service is available.

ACCC results for the IAISIS can be found in Table 4 and 5 below. Table 4 power flow analysis assumes system conditions as of December 31, 2018. Under these assumptions, GEN-2016-098 would be able interconnect up to 250 MW of Interconnection Service.

Table 5 outlines overloads less than 20% TDF, which are **not for transmission reinforcement mitigation.** Generator Interconnection's Energy Resource Interconnection Service (ERIS) analysis doesn't mitigate with additional transmission reinforcement requirements those issues in which the affecting GI request has less than a 20% OTDF. Table 5 is provided for informational purposes so that the Interconnection Customer understands there may be operational conditions when they may be required to reduce their output to maintain system reliability. See Appendix H for full details

Curtailment and System Reliability

In no way does this study guarantee operation for all periods of time. It should be noted that although this study analyzed many of the most probable contingencies, it is not an all-inclusive list and cannot account for every operational situation. Because of this, it is likely that the Customer may be required to reduce their generation output to **0 MW** under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Power Flow Analysis

Table 4: Interconnection Constraints for Transmission Reinforcement Mitigation (Appendix G)

Season	Dispatch Group	Source	Flow	Monitored Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Max MW Available	Contingency
Currently no SPP Transmission Facilities observed in this IAISIS. All thermal and voltage overloads were resolved with previously assigned upgrades.										

Table 5: Constraints not for Transmission Reinforcement Mitigation (Appendix H)

Season	Dispatch Group	Source	Flow	Monitored Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Contingency
Currently no SPP Transmission Facilities observed in this IAISIS.									

Stability Analysis

Transient stability analysis is used to determine if the transmission system can maintain angular stability and ensure bus voltages stay within planning criteria bandwidth during and after a disturbance while considering the addition of a generator interconnection request.

Model Preparation

Transient stability analysis was performed using modified versions of the 2015 series of Model Development Working Group (MDWG) dynamic study models including the 2016 winter, 2017 and 2025 summer peak dynamic cases. The cases were adapted to resemble the power flow study cases with regards to prior queued generation requests and topology. Finally, the prior queued and study generation was dispatched into the SPP footprint. Initial simulations are then carried out for a no-disturbance run of twenty (20) seconds to verify the numerical stability of the model.

Disturbances

Twenty-eight (28) contingencies were identified for use in this study. These faults are listed within Table 8. These contingencies included three-phase faults and single-phase line faults at locations defined by SPP. Single-phase line faults were simulated by applying fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

With exception to transformers, the typical sequence of events for a three-phase and single-phase fault is as follows:

1. apply fault at particular location
2. continue fault for five (5) cycles, clear the fault by tripping the faulted facility
3. after an additional twenty (20) cycles, re-close the previous facility back into the fault
4. continue fault for five (5) additional cycles
5. trip the faulted facility and remove the fault

Transformer faults are typically only performed for three-phase faults, unless otherwise noted. Additionally the sequence of events for a transformer is to 1) apply a three-phase fault for five (5) cycles and 2) clear the fault by tripping the affected transformer facility. Unless otherwise noted there will be no re-closing into a transformer fault.

Table 8: Contingencies Evaluated for Limited Operation

Cont. No.	Contingency Name	Description
1	FLT_01_G16003TAP_G16001TAP_345kV_3PH	3 phase fault on G16-003-TAP (560071) to G16-001-TAP (560070) 345kV Ckt 1, near G16-003-TAP. a. Apply fault at the near G16-003-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
2	FLT_02_G16003TAP_WoodwardEHV_345kV_3PH	3 phase fault on G16-003-TAP (560071) to Woodward EHV (515375) 345kV Ckt 1, near G16-003-TAP. a. Apply fault at the G16-003-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
3	FLT_03_G16001TAP_G1114TAP_345kV_3PH	3 phase fault on G16-001-TAP (560070) to G11-14-TAP (560000) 345kV Ckt 1, near G16-001-TAP 345kV. a. Apply fault at the G16-001-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
4	FLT_04_G1114TAP_BeaverCounty_345kV_3PH	3 phase fault on G11-14-TAP (560000) to Beaver County (515554) 345kV Ckt 1, near G11-14-TAP. a. Apply fault at the G11-14-TAP 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
5	FLT_05_BeaverCounty_G14037TAP_345kV_3PH	3 phase fault on Beaver County (515554) to G14-037-TAP (560010) 345kV Ckt 1, near Beaver County. a. Apply fault at the Beaver County 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
6	FLT_06_G14037TAP_Hitchland_345kV_3PH	3 phase fault on the G14-037-TAP (560010) to Hitchland (523097) 345kV Ckt 1, near G14-037-TAP. a. Apply fault at the G14-037-TAP 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Contingency Name	Description
7	FLT_07_WoodwardEHV_Thistle_345kV_3PH	3 phase fault on Woodward EHV (515375) to Thistle (539801) 345kV Ckt 1, near Woodward EHV. a. Apply fault at the Woodward EHV 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
8	FLT_08_WoodwardEHV_Tatonga_345kV_3PH	3 phase fault on Woodward EHV (515375) to Tatonga (515407) 345kV Ckt 1, near Woodward EHV. a. Apply fault at the Woodward EHV 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
9	FLT_09_WoodwardEHV_Border_345kV_3PH	3 phase fault on Woodward EHV (515375) to Border (515458) 345kV Ckt 1, near Woodward EHV. a. Apply fault at the Woodward EHV 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
10	FLT_10_WoodwardEHV_WoodwardEHV_345_138kV_3PH	3 phase fault on Woodward EHV 345kV (515375) to 138kV (515376) to 13.8kV (515799) Xfmr Ckt 2, near Woodward EHV 345kV. a. Apply fault at the Woodward EHV 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
11	FLT_11_Border_Tuco_345kV_3PH	3 phase fault on Border (515458) to Tuco (525832) 345kV Ckt 1, near Border. a. Apply fault at the Border 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
12	FLT_12_Tatonga_Matthewson_345kV_3PH	3 phase fault Tatonga (515407) to Matthewson (515497) 345kV Ckt 1, near Tatonga a. Apply fault at the Tatonga 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
13	FLT_13_Thistle_G16005TAP_345kV_3PH	3 phase fault on Thistle (539801) to G16-005-TAP (560072) 345kV Ckt 1, near Thistle. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Contingency Name	Description
14	FLT_14_G16005TAP_ClarkCounty_345kV_3PH	3 phase fault on G16-005-TAP (560072) to Clark County (539800) 345kV Ckt 1, near Clark County. a. Apply fault at the Clark County 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
15	FLT_15_Thistle_Thistle_345_138kV_3PH	3 phase fault on Thistle 345kV (539801) to 138kV (539804) to 13.8kV (539802) Xfmr Ckt 1, near Thistle 345kV. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
16	FLT_16_Thistle_G1524&G1525T_345kV_3PH	3 phase fault on Thistle (539801) to G1524&G1525T (560033) 345kV Ckt 1, near Thistle. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
17	FLT_17_G1524&G1525T_Wichita_345kV_3PH	3 phase fault on to G1524&G1525T (560033) to Wichita (532796) 345kV Ckt 1, near G1524&G1525T. a. Apply fault at the G1524&G1525T 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
18	FLT_18_WoodwardEHV_Iodine_138kV_3PH	3 phase fault on Woodward EHV (515376) to Iodine (514796) 138kV Ckt 1, near Woodward EHV. a. Apply fault at the Woodward EHV 138kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
19	FLT_19_WoodwardEHV_WoodwardPAR_138kV_3PH	3 phase fault on Woodward EHV (515376) to Woodward PAR (515997) 138kV Ckt 1, near Woodward EHV. a. Apply fault at the Woodward EHV 138kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
20	FLT_20_WoodwardPAR_Woodward_138kV_3PH	3 phase fault on Woodward PAR (515997) to Woodward (514785) 138kV Ckt 1, near Woodward PAR. a. Apply fault at the Woodward PAR 138kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Contingency Name	Description
21	FLT_21_Woodward_Woodward_138_69kV_3PH	3 phase fault on Woodward 138kV (514785) to 69kV (514782) to 13.2kV (515771) Xfmr Ckt 1, near Woodward 138kV. a. Apply fault at the Woodward 138kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
22	FLT_22_Woodward_Windfarm_138kV_3PH	3 phase fault on Woodward (514785) to Windfarm (515785) 138kV Ckt 1, near Woodward. a. Apply fault at the Woodward 138kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
23	FLT_23_Windfarm_Mooreland_138kV_3PH	3 phase fault on Windfarm (515785) to Mooreland (520999) 138kV Ckt 1, near Windfarm. a. Apply fault at the Windfarm 138kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
24	FLT_24_WoodwardEHV_WoodwardPARSB_138kV_1PH	**Single phase fault with stuck breaker** on the Woodward EHV (515376) to Woodward PAR (515997) 138kV Ckt 1, near Woodward EHV. a. Apply fault at Woodward EHV 138kV bus. b. At 5 cycles, open the faulted line. c. At 15 cycles, clear the fault and trip: Woodward EHV (515376) to Iodine (514796) 138kV Ckt 1
25	FLT_25_WoodwardEHV_WoodwardEHVSB_345_138kV_1PH	**Single phase fault with stuck breaker** on the Woodward EHV 345kV (515375) to 138kV (515376) to 13.8kV (515799) Xfmr Ckt 2, near Woodward EHV 345kV. a. Apply fault at Woodward EHV 345kV bus. b. At 5 cycles, open the faulted line. c. At 15 cycles, clear the fault and trip: Woodward EHV (515375) to Thistle (539801) 345kV Ckt 1
26	FLT_26_Thistle_WoodwardEHVSB_345kV_1PH	**Single phase fault with stuck breaker** on the Thistle (539801) to Woodward EHV (515375) 345kV Ckt 2 near Thistle. a. Apply fault at Thistle 345kV bus. b. At 5 cycles, open the faulted line. c. At 15 cycles, clear the fault and trip: Thistle (539801) to Clark County (539800) 345kV Ckt 1
27	FLT_27_WoodwardEHV_ThistlePO_345kV_3PH	**(Prior Outage)** Border (515458) to Woodward EHV (515375) 345kV Ckt 1 out of service then 3 phase fault on Woodward EHV (515375) to Thistle (539801) 345kV Ckt 1, near Woodward. Switch Border (515458) to Woodward EHV (515375) 345kV Ckt 1 out of service then solve. a. Apply fault at the Woodward EHV 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Cont. No.	Contingency Name	Description
28	FLT_28_WoodwardEHV_ThistlePO_345kV_3PH	**(Prior Outage)** Tatonga (515407) to Matthewson (515497) 345kV Ckt 1 out of service then 3 phase fault on Woodward EHV (515375) to Thistle (539801) 345kV Ckt 1, near Woodward. Tatonga (515407) to Matthewson (515497) 345kV Ckt 1 out of service then solve. a. Apply fault at the Woodward EHV 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Results

Results of the stability analysis are summarized in Table 9. These results are valid for GEN-2016-098 interconnecting with a generation amount up to 250 MW. No stability problems were seen.

Table 9: Fault Analysis Results

Contingency Number and Name		2017SP	2016WP	2025SP
1	FLT_01_G16003TAP_G16001TAP_345kV_3PH	Stable	Stable	Stable
2	FLT_02_G16003TAP_WoodwardEHV_345kV_3PH	Stable	Stable	Stable
3	FLT_03_G16001TAP_G1114TAP_345kV_3PH	Stable	Stable	Stable
4	FLT_04_G1114TAP_BeaverCounty_345kV_3PH	Stable	Stable	Stable
5	FLT_05_BeaverCounty_G14037TAP_345kV_3PH	Stable	Stable	Stable
6	FLT_06_G14037TAP_Hitchland_345kV_3PH	Stable	Stable	Stable
7	FLT_07_WoodwardEHV_Thistle_345kV_3PH	Stable	Stable	Stable
8	FLT_08_WoodwardEHV_Tatonga_345kV_3PH	Stable	Stable	Stable
9	FLT_09_WoodwardEHV_Border_345kV_3PH	Stable	Stable	Stable
10	FLT_10_WoodwardEHV_WoodwardEHV_345_138kV_3PH	Stable	Stable	Stable
11	FLT_11_Border_Tuco_345kV_3PH	Stable	Stable	Stable
12	FLT_12_Tatonga_Matthewson_345kV_3PH	Stable	Stable	Stable
13	FLT_13_Thistle_G16005TAP_345kV_3PH	Stable	Stable	Stable
14	FLT_14_G16005TAP_ClarkCounty_345kV_3PH	Stable	Stable	Stable
15	FLT_15_Thistle_Thistle_345_138kV_3PH	Stable	Stable	Stable
16	FLT_16_Thistle_G1524&G1525T_345kV_3PH	Stable	Stable	Stable
17	FLT_17_G1524&G1525T_Wichita_345kV_3PH	Stable	Stable	Stable
18	FLT_18_WoodwardEHV_Iodine_138kV_3PH	Stable	Stable	Stable
19	FLT_19_WoodwardEHV_WoodwardPAR_138kV_3PH	Stable	Stable	Stable
20	FLT_20_WoodwardPAR_Woodward_138kV_3PH	Stable	Stable	Stable
21	FLT_21_Woodward_Woodward_138_69kV_3PH	Stable	Stable	Stable
22	FLT_22_Woodward_Windfarm_138kV_3PH	Stable	Stable	Stable
23	FLT_23_Windfarm_Mooreland_138kV_3PH	Stable	Stable	Stable
24	FLT_24_WoodwardEHV_WoodwardPARSB_138kV_1PH	Stable	Stable	Stable

Contingency Number and Name		2017SP	2016WP	2025SP
25	FLT_25_WoodwardEHV_WoodwardEHVSB_345_138kV_1PH	Stable	Stable	Stable
26	FLT_26_Thistle_WoodwardEHVSB_345kV_1PH	Stable	Stable	Stable
27	FLT_27_WoodwardEHV_ThistlePO_345kV_3PH	Stable	Stable	Stable
28	FLT_28_WoodwardEHV_ThistlePO_345kV_3PH	Stable	Stable	Stable

FERC LVRT Compliance

FERC Order #661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draw the voltage down at the POI to 0.0 pu.

Fault contingencies were developed to verify that wind farms remain on line when the POI voltage is drawn down to 0.0 pu. These contingencies are shown in Table .

Table 10: LVRT Contingencies

Contingency Number and Name		Description
1	FLT_01_G16003TAP_G16001TAP_345kV_3PH	3 phase fault on G16-003-TAP (560071) to G16-001-TAP (560070) 345kV Ckt 1, near G16-003-TAP.
2	FLT_02_G16003TAP_WoodwardEHV_345kV_3PH	3 phase fault on G16-003-TAP (560071) to Woodward EHV (515375) 345kV Ckt 1, near G16-003-TAP.

The required prior queued project wind farms remained online for the fault contingencies described in this section as well as the fault contingencies described in the Disturbances section of this report. GEN-2016-098 is found to be in compliance with FERC Order #661A.

Power Factor Analysis

In accordance with FERC Order 827 GEN-2016-098 will be required to provide dynamic reactive power within the power factor range of 0.95 leading (absorbing Vars from the network) to 0.95 lagging (providing Vars to the network) at continuous rated power output at the high side of the generator substation.

Reduced Wind Generation Analysis

A low wind analysis has been performed for the GEN-2016-098 Interconnection Request. SPP performed this low wind analysis for excessive capacitive charging current for the addition of the Interconnection Request facilities. The high side of the each Interconnection Customer's transformer will interconnect to The Point of Interconnection (POI).

The project generators and capacitors (if any) were turned off in the base case. The resulting reactive power injection into the transmission network comes from the capacitance of the project's transmission lines and collector cables is shown in Figure C-1 **and C-2**.

Final shunt reactor requirement for each project with the model information provided to SPP is shown in **Table 11**. It is the interconnection customer's responsibility to design and install the reactive compensation equipment necessary to control the reactive power injection at the POI. If an equivalent means of compensation is installed, the reactive power required may vary with system conditions (e.g. a higher compensation amount is required for voltages above unity at the POI and a lower compensation amount is required for voltages below unity at the POI).

Table 11*: Summary of Reduced Wind Generation Analysis*

Request	Point of Interconnection (POI)	Reactor Size (Mvar)
GEN-2016-098	G16-003-TAP 345kV (560071)	24.0

Short Circuit Analysis

The short circuit analysis was performed on the 2017 & 2025 Summer Peak power flow cases using the PSS/E ASCC program. Since the power flow model does not contain negative and zero sequence data, only three-phase symmetrical fault current levels were calculated at the point of interconnection up to and including five levels away.

Short Circuit Analysis was conducting using flat conditions with the following PSS/E ASCCC program settings:

- BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
- GENERATOR P=0, Q=0
- TRANSFORMER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
- LINE CHARGING=0.0 IN +/-/0 SEQUENCE
- LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
- LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
- DC LINES AND FACTS DEVICES BLOCKED
- TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

Results

The results of the short circuit analysis are shown in **Appendix D.**

Conclusion

GEN-2016-098 (Interconnection Customer) has requested an Interim Availability Interconnection System Impact Study (IAISIS) under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 250 MW of wind generation to be interconnected with Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS) into the transmission system of Oklahoma Gas and Electric (OKGE) in Harper County, Oklahoma. The point of interconnection will be a new substation tapping Woodward – Hitchland 345 kV. GEN-2016-098 under GIA Section 11A, has requested this Interim Availability Interconnection System Impact Study (IAISIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2016-002 (or most recent iteration) Impact Study can be placed into service.

Power flow analysis from this IAISIS has determined that the GEN-2016-098 request can interconnect 250 MW of generation with Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS) prior to the completion of the required Network Upgrades, listed within
Table *2* of this report. However, full interconnection service is dependent on all previously assigned upgrades being in-service. Should any higher-queued requests withdraw from study, a restudy may be required. Furthermore, any upgrades assigned to those higher-queued requests would also be subject to restudy, which might trigger a restudy for this request. Should any other projects, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available. Refer to Table 4 for the Limited Operation Interconnection Service available due to interconnection constraints.

Additionally, GEN-2016-036 was found to be in compliance with FERC Order #661A when studied as listed within this report.

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study execute an interconnection agreement and commencing commercial operation, may require a re-study of this IAISIS at the expense of the Customer.

Nothing in this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service.

Appendices

A: Affected System Thermal Power Flow Analysis (Constraints for Potential Transmission Reinforcement)

See next page.

B: Affected System Voltage Power Flow Analysis (Constraints for Potential Transmission Reinforcement)

See next page.

C: Reduced Wind Generation Analysis Results

Below figures are from the 2016WP model with identified upgrades in-service. The other 2 cases (2017SP and 2025SP) were almost identical since the Interconnection Request facilities design is the same in all cases.

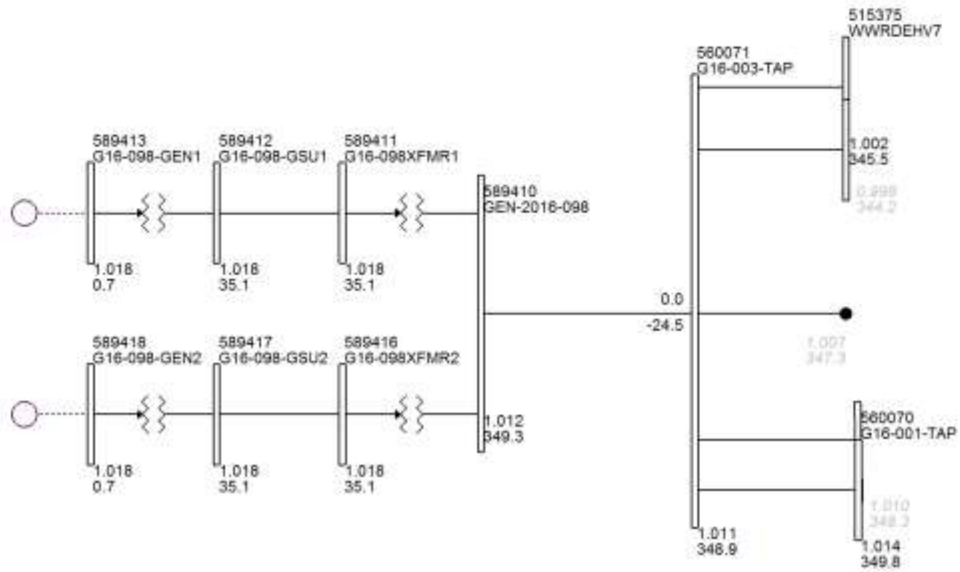
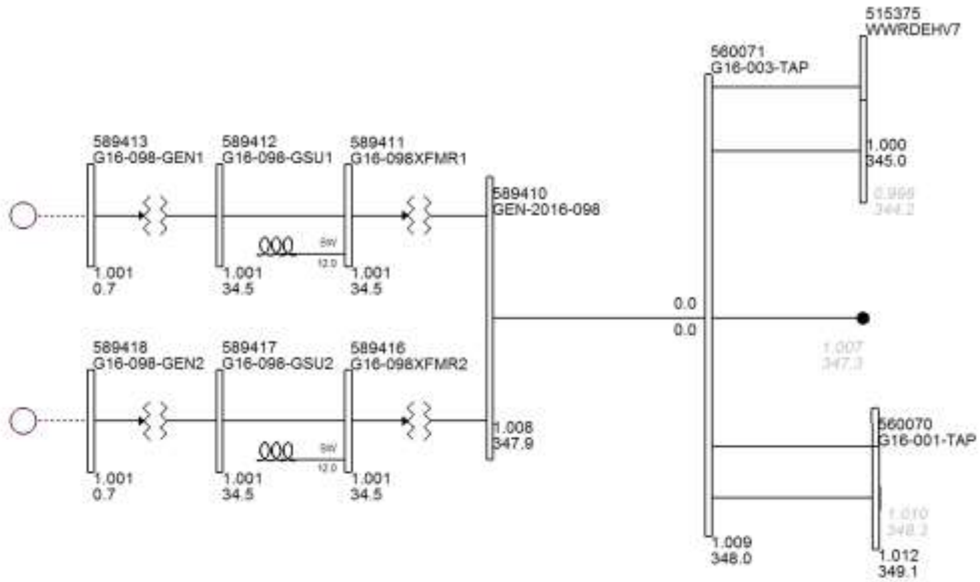


Figure C-1*:* GEN-2016-098 with generators turned off

Figure C-2*:* GEN-2016-098 with generators turned off and shunt reactors added to the customer 34.5kV substation


515375
WWRDEHV7
560071
G16-003-TAP
589413
G16-098-GEN1
589412
G16-098-GSU1
589411
G16-098XFMR1
1.000
345.0
589410
GEN-2016-098
1.001
0.7
1.001
34.5
1.001
34.5
0.0
0.0
589418
G16-098-GEN2
589417
G16-098-GSU2
589416
G16-098XFMR2
1.008
347.9
560070
G16-001-TAP
1.001
0.7
1.001
34.5
1.001
34.5
1.009
348.0
1.012
349.1

D: Short Circuit Analysis Results

17SP

```
                             PSS®E ASCC SHORT CIRCUIT CURRENTS
THU, FEB 01 2018  15:07
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 17S WITH MMWG 15S, MRO 16W TOPO/16S PROF, SERC 16S

OPTIONS USED:
    - FLAT CONDITIONS
         - BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
         - GENERATOR P=0, Q=0
         - TRANSFOMRER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
         - LINE CHARGING=0.0 IN +/-/0 SEQUENCE
         - LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
         - LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0
IN +/-/0 SEQUENCE
         - DC LINES AND FACTS DEVICES BLOCKED
         - TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

                                  THREE PHASE FAULT
X--------- BUS ----------X           /I+/    AN(I+)
560071 [G16-003-TAP 345.00] AMP    14176.8   -86.30
515375 [WWRDEHV7    345.00] AMP    16907.2   -86.02
560070 [G16-001-TAP 345.00] AMP    13116.3   -86.36
587020 [GEN-2016-003345.00] AMP    14176.8   -86.30
589410 [GEN-2016-098345.00] AMP     9426.2   -85.37
515376 [WWRDEHV4    138.00] AMP    21584.1   -85.97
515407 [TATONGA7    345.00] AMP    10329.8   -86.73
515458 [BORDER     7345.00] AMP     4958.5   -86.22
515599 [G07621119-20345.00] AMP    11992.8   -85.59
539801 [THISTLE7    345.00] AMP    16125.5   -85.88
560000 [G11-14-TAP  345.00] AMP    13591.7   -86.41
514796 [IODINE-4    138.00] AMP     7124.0   -79.86
515394 [KEENAN 4    138.00] AMP     7842.3   -84.88
515398 [OUSPRT 4    138.00] AMP     8596.2   -82.17
515448 [CRSRDSW7    345.00] AMP     8058.8   -85.96
515497 [MATHWSN7    345.00] AMP    30509.4   -85.66
515554 [BVRCNTY7    345.00] AMP    14644.5   -86.35
515582 [SLNGWND7    345.00] AMP     6976.5   -85.73
515585 [MAMTHPW7    345.00] AMP     9163.0   -86.57
515997 [WWPAR4      138.00] AMP    16222.1   -84.09
525832 [TUCO_INT   7345.00] AMP     9898.6   -85.89
539804 [THISTLE4    138.00] AMP    16634.7   -86.53
560033 [G1524&G1525T345.00] AMP    20809.5   -86.29
560072 [G16-005-TAP 345.00] AMP    13455.3   -85.17
581112 [GEN-2011-014345.00] AMP    12172.8   -86.18
```

583090	[G1149&G1504 345.00]	AMP	4544.2	-86.07
584700	[GEN-2015-029345.00]	AMP	7281.5	-85.24
585190	[GEN-2015-082345.00]	AMP	7003.8	-85.56
585410	[GREAT_WESTRN345.00]	AMP	9297.1	-85.31
585430	[PRSIMN_CRK1 345.00]	AMP	10685.9	-85.47
511456	[O.K.U.-7 345.00]	AMP	5015.2	-84.33
514785	[WOODWRD4 138.00]	AMP	12131.9	-80.65
514787	[DEWEY 4 138.00]	AMP	7186.4	-77.22
514880	[NORTWST7 345.00]	AMP	30970.8	-85.97
514901	[CIMARON7 345.00]	AMP	31466.1	-85.64
515590	[PALDR2W7 345.00]	AMP	12414.2	-86.05
525830	[TUCO_INT 6230.00]	AMP	19465.9	-84.44
532796	[WICHITA7 345.00]	AMP	25103.5	-86.09
539638	[FLATRDG4 138.00]	AMP	14902.4	-85.89
539800	[CLARKCOUNTY7345.00]	AMP	14626.9	-84.47
560010	[G14-037-TAP 345.00]	AMP	15479.2	-86.09
560055	[G15-063T 345.00]	AMP	17876.6	-84.83
578542	[GEN-2010-001345.00]	AMP	11957.2	-85.21
579272	[G0744&1403HV345.00]	AMP	6976.5	-85.73
583760	[GEN-2013-030345.00]	AMP	11908.3	-85.84
584659	[G15024G15025345.00]	AMP	6895.1	-86.51
585060	[GEN-2015-068345.00]	AMP	8365.9	-85.73
585420	[COWBOY_RIDGE345.00]	AMP	7297.1	-85.06
585440	[PRSIMN_CRK2 345.00]	AMP	9830.0	-85.37
587040	[GEN-2016-005345.00]	AMP	10983.9	-85.03
587300	[G16-045-SUB1345.00]	AMP	2833.2	-86.02
587304	[G16-045-SUB2345.00]	AMP	2791.3	-86.03
587380	[G16-057-SUB1345.00]	AMP	2809.8	-86.03
587384	[G16-057-SUB2345.00]	AMP	2740.5	-86.09
587500	[GEN-2016-073345.00]	AMP	15748.3	-85.90
511468	[L.E.S.-7 345.00]	AMP	12042.6	-84.68
514715	[WOODRNG7 345.00]	AMP	18991.8	-84.89
514782	[WODWRD 2 69.000]	AMP	10648.1	-83.24
514801	[MINCO 7 345.00]	AMP	16431.5	-85.08
514822	[SOUTHRD4 138.00]	AMP	3934.2	-74.26
514879	[NORTWST4 138.00]	AMP	43188.4	-85.91
514881	[SPRNGCK7 345.00]	AMP	22143.5	-85.44
514898	[CIMARON4 138.00]	AMP	42455.6	-84.97
514908	[ARCADIA7 345.00]	AMP	25182.6	-86.43
514934	[DRAPER 7 345.00]	AMP	20583.3	-85.09
515363	[CENT 4 138.00]	AMP	3044.6	-77.55
515390	[TLGAWND4 138.00]	AMP	3566.2	-79.94
515610	[FSHRTAP7 345.00]	AMP	16351.0	-85.00
515634	[PALDR1W7 345.00]	AMP	10614.8	-85.82
515785	[WINDFRM4 138.00]	AMP	19870.9	-82.25
521065	[TALOGA 4 138.00]	AMP	7103.8	-76.83
523097	[HITCHLAND 7345.00]	AMP	15744.1	-86.02
525213	[SWISHER 6230.00]	AMP	10343.9	-82.44

```
525524 [TOLK_EAST  6230.00] AMP    25581.2   -86.11
525828 [TUCO_INT   3115.00] AMP    19228.3   -82.67
525840 [ANTELOPE_1 6230.00] AMP    19320.3   -84.45
526161 [CARLISLE   6230.00] AMP    11926.0   -83.54
526337 [JONES      6230.00] AMP    19602.5   -86.20
532771 [RENO   7    345.00] AMP    10825.7   -85.56
532791 [BENTON 7    345.00] AMP    19484.9   -85.69
532798 [VIOLA   7   345.00] AMP    11652.4   -85.06
533040 [EVANS N4    138.00] AMP    37732.5   -87.19
539631 [FLATRWD4    138.00] AMP     9803.2   -83.98
539668 [HARPER 4    138.00] AMP     5688.7   -80.21
539674 [BARBER 4    138.00] AMP     8100.6   -83.92
560002 [IRONWOOD7   345.00] AMP    14721.2   -84.84
560080 [G16-046-TAP 345.00] AMP    12932.0   -79.35
562476 [G14-001-TAP 345.00] AMP    11063.7   -85.01
582008 [GEN-2011-008345.00] AMP    11655.0   -84.07
583340 [GEN-2012-020230.00] AMP     8692.7   -84.11
583370 [GEN-2012-024345.00] AMP    12282.2   -84.41
584210 [GEN-2014-037345.00] AMP    11084.6   -83.41
584660 [GEN-2015-024345.00] AMP     5711.7   -86.54
584670 [GEN-2015-025345.00] AMP     6895.1   -86.51
585010 [GEN-2015-063345.00] AMP    17564.2   -84.76
```

25SP

PSS®E ASCC SHORT CIRCUIT CURRENTS

THU, FEB 01 2018 15:07

2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO

MDWG 2025S WITH MMWG 2024S, MRO & SERC 2025 SUMMER

OPTIONS USED:

- FLAT CONDITIONS
    - BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
    - GENERATOR P=0, Q=0
    - TRANSFOMRER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
    - LINE CHARGING=0.0 IN +/-/0 SEQUENCE
    - LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
    - LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
    - DC LINES AND FACTS DEVICES BLOCKED
    - TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

X---------- BUS ----------X		THREE PHASE FAULT /I+/	AN(I+)
560071 [G16-003-TAP 345.00]	AMP	15206.9	-86.34
515375 [WWRDEHV7 345.00]	AMP	19230.3	-86.09
560070 [G16-001-TAP 345.00]	AMP	13718.3	-86.38
587020 [GEN-2016-003345.00]	AMP	15206.9	-86.34
589410 [GEN-2016-098345.00]	AMP	9855.7	-85.35
515376 [WWRDEHV4 138.00]	AMP	22592.1	-86.13
515407 [TATONGA7 345.00]	AMP	15944.0	-86.52
515458 [BORDER 7345.00]	AMP	5081.1	-86.22
515599 [G07621119-20345.00]	AMP	12975.5	-85.56
539801 [THISTLE7 345.00]	AMP	16478.3	-85.90
560000 [G11-14-TAP 345.00]	AMP	13952.5	-86.43
514796 [IODINE-4 138.00]	AMP	7183.0	-79.86
515394 [KEENAN 4 138.00]	AMP	7971.7	-84.92
515398 [OUSPRT 4 138.00]	AMP	8752.0	-82.16
515448 [CRSRDSW7 345.00]	AMP	11110.1	-85.52
515497 [MATHWSN7 345.00]	AMP	32666.4	-85.95
515554 [BVRCNTY7 345.00]	AMP	14908.0	-86.36
515582 [SLNGWND7 345.00]	AMP	8988.0	-85.24
515585 [MAMTHPW7 345.00]	AMP	13264.2	-86.31
515997 [WWPAR4 138.00]	AMP	16685.6	-84.15
525832 [TUCO_INT 7345.00]	AMP	12081.8	-86.10
539804 [THISTLE4 138.00]	AMP	16851.6	-86.44
560033 [G1524&G1525T345.00]	AMP	21337.3	-86.39
560072 [G16-005-TAP 345.00]	AMP	13547.2	-85.17
581112 [GEN-2011-014345.00]	AMP	12459.3	-86.18
583090 [G1149&G1504 345.00]	AMP	4644.0	-86.07
584700 [GEN-2015-029345.00]	AMP	9608.4	-84.58
585190 [GEN-2015-082345.00]	AMP	7093.5	-85.55

```
585410 [GREAT_WESTRN345.00] AMP     9827.7   -85.27
585430 [PRSIMN_CRK1 345.00] AMP    11446.7   -85.43
511456 [O.K.U.-7    345.00] AMP     5103.2   -84.32
514785 [WOODWRD4    138.00] AMP    12258.0   -80.71
514787 [DEWEY  4    138.00] AMP     7209.2   -77.21
514880 [NORTWST7    345.00] AMP    32085.1   -86.01
514901 [CIMARON7    345.00] AMP    32866.5   -85.87
515590 [PALDR2W7    345.00] AMP    12600.4   -86.05
525830 [TUCO_INT   6230.00] AMP    22501.9   -84.98
526936 [YOAKUM_345  345.00] AMP     8581.1   -86.22
532796 [WICHITA7    345.00] AMP    26066.2   -86.23
539638 [FLATRDG4    138.00] AMP    15103.0   -85.76
539800 [CLARKCOUNTY7345.00] AMP    14704.6   -84.47
560010 [G14-037-TAP 345.00] AMP    15654.0   -86.09
560055 [G15-063T    345.00] AMP    18258.8   -84.87
578542 [GEN-2010-001345.00] AMP    12129.4   -85.20
579272 [G0744&1403HV345.00] AMP     8988.0   -85.24
583760 [GEN-2013-030345.00] AMP    12074.6   -85.84
584659 [G15024G15025345.00] AMP     6939.0   -86.53
585060 [GEN-2015-068345.00] AMP     9835.3   -85.85
585420 [COWBOY_RIDGE345.00] AMP     7604.6   -85.01
585440 [PRSIMN_CRK2 345.00] AMP    10466.7   -85.33
587040 [GEN-2016-005345.00] AMP    11043.7   -85.03
587300 [G16-045-SUB1345.00] AMP     2836.0   -86.02
587304 [G16-045-SUB2345.00] AMP     2793.9   -86.03
587380 [G16-057-SUB1345.00] AMP     2812.5   -86.03
587384 [G16-057-SUB2345.00] AMP     2742.9   -86.09
587500 [GEN-2016-073345.00] AMP    16033.4   -85.96
511468 [L.E.S.-7    345.00] AMP    12314.8   -84.69
514715 [WOODRNG7    345.00] AMP    19316.1   -84.91
514782 [WODWRD 2    69.000] AMP    10695.4   -83.25
514801 [MINCO  7    345.00] AMP    16779.3   -85.14
514822 [SOUTHRD4    138.00] AMP     3937.3   -74.25
514879 [NORTWST4    138.00] AMP    43697.7   -85.96
514881 [SPRNGCK7    345.00] AMP    22593.7   -85.44
514898 [CIMARON4    138.00] AMP    42932.2   -85.04
514908 [ARCADIA7    345.00] AMP    26360.5   -86.52
514934 [DRAPER 7    345.00] AMP    20744.6   -85.07
515363 [CENT   4    138.00] AMP     3050.4   -77.55
515390 [TLGAWND4    138.00] AMP     3570.8   -79.94
515610 [FSHRTAP7    345.00] AMP    16679.5   -85.08
515634 [PALDR1W7    345.00] AMP    10748.8   -85.81
515785 [WINDFRM4    138.00] AMP    19976.7   -82.23
521065 [TALOGA 4    138.00] AMP     7124.8   -76.81
523097 [HITCHLAND  7345.00] AMP    15905.4   -86.02
525213 [SWISHER    6230.00] AMP    10497.6   -82.42
525524 [TOLK_EAST  6230.00] AMP    26347.9   -86.08
525828 [TUCO_INT   3115.00] AMP    20064.7   -82.95
```

```
525840 [ANTELOPE_1 6230.00] AMP    22326.7   -84.99
526161 [CARLISLE   6230.00] AMP    14889.8   -84.11
526337 [JONES      6230.00] AMP    21470.1   -86.12
526935 [YOAKUM     6230.00] AMP    15490.0   -84.71
527896 [HOBBS_INT  7345.00] AMP     8411.3   -86.72
532771 [RENO   7    345.00] AMP    11597.4   -85.94
532791 [BENTON 7    345.00] AMP    19824.2   -85.72
532798 [VIOLA   7   345.00] AMP    13808.8   -85.42
533040 [EVANS N4    138.00] AMP    42821.7   -87.27
539631 [FLATRWD4    138.00] AMP     9889.1   -83.88
539668 [HARPER 4    138.00] AMP     5979.9   -79.19
539674 [BARBER 4    138.00] AMP     8151.5   -83.86
560002 [IRONWOOD7   345.00] AMP    14779.1   -84.82
560080 [G16-046-TAP 345.00] AMP    12980.7   -79.32
562476 [G14-001-TAP 345.00] AMP    11156.3   -85.03
582008 [GEN-2011-008345.00] AMP    11698.7   -84.06
583340 [GEN-2012-020230.00] AMP     9141.2   -84.21
583370 [GEN-2012-024345.00] AMP    12336.5   -84.41
584210 [GEN-2014-037345.00] AMP    11169.8   -83.39
584660 [GEN-2015-024345.00] AMP     5740.1   -86.56
584670 [GEN-2015-025345.00] AMP     6939.0   -86.53
585010 [GEN-2015-063345.00] AMP    17932.0   -84.81
```